National Transportation Safety Board
Aviation Incident Final Report

Location:	Sarasota, FL	**Incident Number:**	ENG04IA021
Date & Time:	07/12/2004, 0001 EDT	**Registration:**	N455CW
Aircraft:	Raytheon Corporate Jets Beechjet 400A	**Aircraft Damage:**	None
Defining Event:		**Injuries:**	9 None
Flight Conducted Under:			

Analysis

The Raytheon Beechjet 400A was descending through flight level 390 when both of the engines flamed out and lost all power while operating in instrument meteorological conditions with convective storms in the area. The pilots, after several attempts, were able to get one engine restarted as the airplane was descending through 10,000 feet and diverted to a nearby airport. Testing of the engines immediately after the incident revealed that they were operating correctly. Testing of the fuel revealed that it conformed to the specifications for Jet A, but the fuel system icing inhibitor (FSII) was significantly below the required concentration. The investigation of two subsequent dual-engine flame out incidents revealed the FSII was not a factor. Convective weather can lift significant amounts of water into the upper atmosphere that then form ice crystals. Research indicates that the ice crystals can partially melt passing through the JT15D-5 engine fan that can then accrete to an internal compressor stator. When any accreted ice was shed from the stator vanes, it would pass through the high pressure compressor and could be picked up by the pressure sense line to the fuel control. Flight tests confirmed that sense line could go below freezing at low power settings at high altitude. Other tests showed that if the sense line was blocked and the power levers were retarded, the electronic engine control would reduce the fuel flow to reduce the power, but the sense pressure within the fuel control would be maintained. But when the blockage was cleared, the sudden reduction in the sense pressure in the fuel control would result in a reduction of the fuel flow at a rate that was much faster than a normal rapid power reduction and could result in the engine flaming out.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be: High-altitude ice crystals that had accreted on the compressor vanes and were ingested into the high pressure compressor when the pilots retarded the power levers causing compressor surges and flameouts of both engines. Contributing factors were the lack of training on the hazards of

high-altitude ice crystals to gas turbine engines and guidance to the pilots to activate the engine anti-ice system in conditions where high-altitude ice crystals may exist.

Findings

Occurrence #1: LOSS OF ENGINE POWER
Phase of Operation: DESCENT

Findings
1. (C) 2 ENGINES - ICE INGESTION
2. DOCUMENTATION - NOT AVAILABLE - FLIGHTCREW
3. (F) PROCEDURE INADEQUATE - MANUFACTURER
4. (F) INFORMATION UNAVAILABLE - MANUFACTURER

Factual Information

HISTORY OF FLIGHT

On July 12, 2004, about 1210 eastern daylight time, a Raytheon Beechjet 400A airplane, N455CW, operated by Flight Options of Cleveland Ohio, experienced a dual-engine flameout of the Pratt & Whitney Canada (PWC) JT15D-5 engines while descending through flight level (FL) 390 over the Gulf of Mexico about 100 miles west of Sarasota, Florida. The pilots, after several attempts, were able to get the right engine restarted as they descended through 10,000 feet and diverted to Sarasota for landing without further incident. Daytime instrument meteorological conditions (IMC) prevailed at the time the engines lost power. The airplane was operating on an instrument flight rules flight plan under 14 CFR Part 135 from Duncan, Oklahoma to Fort Myers, Florida. The two pilots and seven passengers on board were not injured.

The pilots stated that they were cruising at FL 410 in IMC and air traffic control (ATC) cleared the airplane to descend to FL 330. As the airplane was passing through FL 390, the pilots felt a jolt and heard a bang and about 30 seconds later, they realized the airplane was losing cabin pressure. They donned their oxygen masks, declared an emergency, and went through the emergency descent checklist that included confirming the passengers' oxygen masks had been released and were being used. The pilots stated that as the airplane was passing through FL 350, they noticed that every warning light in the cockpit was illuminated and that the engines were not operating. After several unsuccessful attempts to restart the engines, the pilots were able to get the right engine restarted as the airplane descended through 10,000 feet.

TESTS AND RESEARCH

Following the incident, the airplane and engines were tested and no discrepancies were noted. Fuel from the airplane underwent tests at a petrochemical laboratory that revealed the fuel conformed to the requirements for Jet A. But the tests also revealed the concentration of the fuel system icing inhibitor (FSII) was 0.02 percent. Although FSII is not a requirement for Jet A, the Beechjet 400A airplane flight manual (AFM) specifies that the airplane's fuel must have an FSII in concentrations of 0.1 to 0.15 percent.

At the time the engines flamed out, the airplane was in IMC. Weather satellite imagery revealed there were convective weather cells in the area where the airplane's engines flamed out. According to the Federal Aviation Administration's (FAA) engine icing expert, convective weather can lift significant amounts of moisture into the upper atmosphere and the blow off from the tops of these convective storms can contain significant amounts of ice crystals.

PWC did a study to determine if high altitude ice crystals could adhere to the inside of a JT15D-5 engine to the point that it would flame out. The study revealed that it was possible for ice crystals to partially melt passing through the fan and with the anti-ice turned off, to accrete on the leading edges of the front inner compressor stator vanes. Any change in engine speed would change the airflow's angle of incidence over the stators causing any accreted ice to be blown off of the stator vane. The study showed that if a significant amount of ice had accreted on the stator vanes and was blown off, it could result in the engine surging and possibly flaming out. In addition, any ice that may have accreted within the engine would degrade the engine's compressor efficiency, surge margin, and relight capability. Additionally, the ice that was blown off of the stator vanes would melt passing through the high pressure compressor that could be then picked up by the P3 (compressor discharge pressure) line that goes to the

fuel control.

Raytheon conducted a flight test of a Beechjet 400A airplane that had thermocouples installed on the P3 line adjacent to the fuel control on one engine. The testing revealed that the temperature of the line would go below freezing at low power settings when the engine was operated in ambient conditions like those when the airplane's engines flamed out. PWC developed a rig test to simulate the effect of a blocked P3 line. The testing revealed that if the line was blocked when the power lever was retarded, the electronic engine control would reduce the fuel flow even though the pressure was maintained in the fuel control P3 bellows. When the line became unblocked, either by the pressure differential or the melting of an ice blockage, the sudden drop in the P3 bellows pressure resulted in the fuel flow dropping faster than in a normal rapid engine deceleration that could result in the engine flaming out.

The Safety Board issued Urgent Safety Recommendation A-06-56 that requested the FAA to Beechjet 400 pilots to activate the engine anti-ice at high altitudes whenever they were in or near visible moisture or convective storm activity. On September 15, 2006, Raytheon issued a temporary change to the Beechjet 400 AFM that provided guidelines for turning on the engine anti-ice at high altitudes when in the vicinity of visible moisture and convective storm activity. The FAA issued Airworthiness Directive 2006-21-02 that required operators of Beechjet 400 airplanes to incorporate the temporary revision into their airplanes AFM.

Pilot Information

Certificate:	Airline Transport	**Age:**	47, Male
Airplane Rating(s):	Multi-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without Waivers/Limitations	**Last FAA Medical Exam:**	
Occupational Pilot:		**Last Flight Review or Equivalent:**	04/01/2004
Flight Time:	13633 hours (Total, all aircraft), 1833 hours (Total, this make and model)		

Co-Pilot Information

Certificate:	Airline Transport	**Age:**	64, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Right
Other Aircraft Rating(s):		**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without Waivers/Limitations	**Last FAA Medical Exam:**	07/01/2004
Occupational Pilot:		**Last Flight Review or Equivalent:**	06/01/2004
Flight Time:	16000 hours (Total, all aircraft), 2500 hours (Total, this make and model), 5000 hours (Pilot In Command, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Raytheon Corporate Jets	**Registration:**	N455CW
Model/Series:	Beechjet 400A	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Transport	**Serial Number:**	RK-365
Landing Gear Type:		**Seats:**	10
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	16300 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo Fan
Airframe Total Time:	585 Hours at time of accident	**Engine Manufacturer:**	Pratt & Whitney Canada
ELT:	Not installed	**Engine Model/Series:**	JT15D-5
Registered Owner:	Flight Options	**Rated Power:**	2965 lbs
Operator:	Flight Options	**Operating Certificate(s) Held:**	On-demand Air Taxi (135)
Operator Does Business As:	Flight Options	**Operator Designator Code:**	

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:		**Distance from Accident Site:**	
Observation Time:		**Direction from Accident Site:**	
Lowest Cloud Condition:		**Visibility**	
Lowest Ceiling:		**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:		**Temperature/Dew Point:**	
Precipitation and Obscuration:			
Departure Point:	Duncan, OK (KDUC)	**Type of Flight Plan Filed:**	IFR
Destination:	Fort Myers, FL (KRSW)	**Type of Clearance:**	IFR
Departure Time:		**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	2 None	**Aircraft Damage:**	None
Passenger Injuries:	7 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	9 None	**Latitude, Longitude:**	

Administrative Information

Investigator In Charge (IIC):	Jim Hookey	**Report Date:**	12/20/2007
Additional Participating Persons:	Stephen P Stiyer; Tampa		
Publish Date:	05/21/2013		
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/.		